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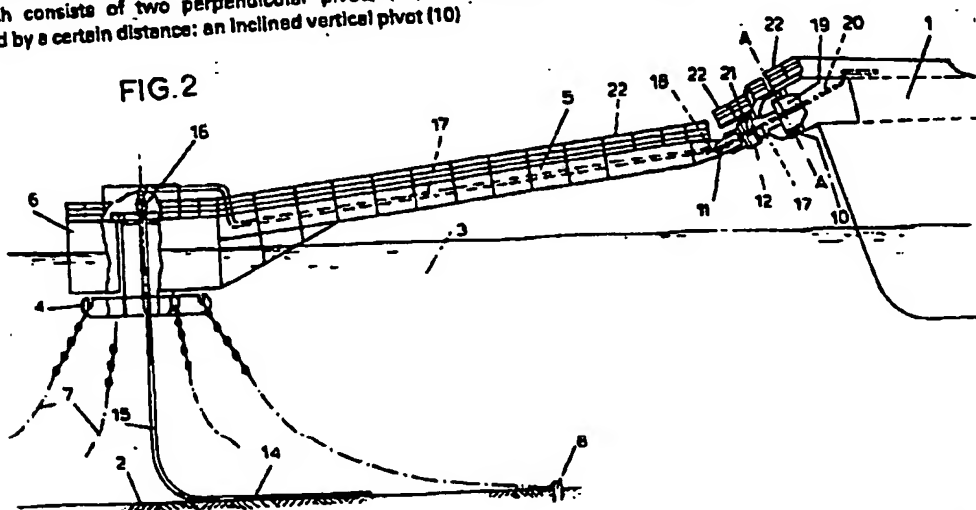
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(54) A buoy and mooring arrangement.

(57) A buoy with a mooring arrangement is disclosed, consisting of a buoy (6) with an integrated rigid arm (5). The mooring arrangement and rigid arm are free to rotate about the vertical axis of the buoy (6). The rigid arm (5) is connected to the mooring arrangement by a universal joint (9), which consists of two perpendicular pivots (10, 11) separated by a certain distance: an inclined vertical pivot (10)

adjacent to the mooring arrangement and a horizontal pivot (11) at the end of the rigid arm. The weight of the rigid arm (5), the loading on the horizontal pivot and the inclination of the vertical pivot combine to produce a restoring moment which prevents jack-knifing when the rigid arm moves out of line with the centreline of the mooring arrangement.

FIG.2



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A BUOY AND MOORING ARRANGEMENT

BACKGROUND OF THE INVENTION

The present invention relates to a buoy with an associated mooring arrangement floating on the surface of a body of water; this buoy is anchored by means of a number of anchors and anchor chains to the floor of the body of water, while the associated mooring arrangement is coupled to the buoy by a rigid arm which serves to hold the mooring arrangement away from the buoy. This member is at one end pivotably hinged on the horizontally disposed pin affixed to the mooring arrangement, and at the other end is coupled to the buoy in such a manner that the mooring arrangement is free to swing about the vertical axis of the buoy. Such a buoy with an associated mooring arrangement is known from the Dutch Patent Applications 6600321 and 7207903, laid open to public inspection.

In this known embodiment of the buoy with its associated mooring arrangement the rigid arm is pivotably hinged to the mooring arrangement; this connection is made by means of a horizontally disposed pivot. The buoy and mooring arrangement, the latter of which is in many instances a tanker, are subject to the motions of the waves within the body of water and the forces exerted by the wind. Consequently, the rigid arm needs to have a considerable inherent strength and stiffness to cope with the forces exerted upon it by the mooring arrangement. These forces attempt to turn the buoy over or force it sideways in relation to the connected mooring arrangement or tanker. This situation implies that the rigid arm needs to have a relatively large width at the end which connects to the mooring arrangement or tanker in order to provide adequate strength and stability, with the result that an expensive construction and/or extensive vessel modifications are necessary.

A structure which is subject to considerably reduced loads is achieved by attaching the rigid arm to the mooring arrangement/tanker by means of a universal joint which allows pivotational movement in all directions. Hence the rigid arm does not require any torsional stiffness, and the strength of the rigid arm does not need to exceed the forces necessary to transfer the anchoring forces of the mooring arrangement to the anchor chains.

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The buoy is fitted to the mooring arrangement or tanker in a similar way as a caravan is connected to an automobile; this implies that only the distance between the buoy and the mooring arrangement is maintained whilst no other restriction in motion is implied. The buoy and rigid arm will
5 Jack-knife when the mooring arrangement is pushed towards the buoy by a reverse current, such as occurs during a change in tide. The rigid arm and buoy will be pushed against the side of the ship's hull under such circumstances, and this will result in very high peak loads on the universal joint connection between the rigid arm and the coupling member
10 as a result of the swell motions. This jack-knifing, which also occurs if the mooring arrangement is connected to the buoy with a rope, can be prevented by the provision of a propulsion source which constantly pulls the coupling member away from the buoy.

SUMMARY OF THE INVENTION

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It is the general objective of the present invention to provide a novel type of apparatus for anchoring a mooring arrangement on the surface of a body of water to the floor of that body of water which provides a construction
20 that allows the jack-knifing of the rigid arm and provides a sufficient restoring moment to restrict the jack-knifing without any driving means. This is achieved by splitting the universal joint between the rigid arm and the mooring arrangement into three independent and perpendicular pivotable connections: the pivotable connection with the mooring arrangement is arranged in an inclined vertical direction; a pivotable connection which is perpendicular to the centreline of the rigid arm and which pivots about a
25 horizontal axis is located a certain distance away from the inclined vertical pivotable connection; finally, the pivotable connection along the centreline of the rigid arm can be located between the two other pivotable connections or in the rigid arm itself. Alternatively, the pivotable connection along the centreline can be omitted entirely.
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Since the vertically pivotable connection is fitted into the mooring arrangement or tanker with an inclination, the weight of the rigid arm inclusive of
35 the weight of the horizontally pivotable hinge located at a certain distance from the pivotable connection which is inclined from the vertical provides a

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restoring moment when the buoy and rigid arm move out of line with the centreline of the mooring arrangement or tanker. The restoring moment is proportional to the weight of the rigid arm inclusive of the weight of horizontally pivotable hinge, the sine of the angle of inclination from the vertical of the inclined vertical pivotable connection, and a factor $(1 - \cos \theta)$ in which θ is the angle of jack-knifing.

The restoring moment can be altered by changing the inclination of the 'vertical' pivotable connection or by changing the weight of the rigid arm using ballast; depending on the demands imposed by the dimensions of the mooring arrangement, the expected weather and storm conditions, etc..

A preferred embodiment of the present invention would involve the rigid arm being provided with a ballasting arrangement that could be emptied to enable it to act as a floating unit. This would provide the buoy with a stable buoyancy capacity should the buoy and mooring arrangement be disconnected.

In the Dutch Patent Application 6414787, laid open to public inspection, a normal buoy with turntable is described in which the turntable is fitted to a framework provided with floaters. This rigid arm is connected to the turntable of the buoy by couplings that pivot about a vertical axis. The mooring arms thus consists of two members which are interconnected by a hinge which allows pivoting motions about the horizontal axis, and the mooring arm or arms are fitted to the side of the vessel. This embodiment has no elements that will activate the aforementioned restoring moment, and will therefore be unsuitable in areas where sea currents may reverse in direction.

BRIEF DESCRIPTION OF THE DRAWINGS

Further and additional objects and advantages of the present invention will become apparent to those skilled in the art when considering the following detailed description and accompanying drawings, wherein like elements have been given like numbers, in which: FIGURE 1 is a plan view of a preferred embodiment of the apparatus of the present invention. FIGURE 2 is an elevation of the apparatus shown in Figure 1.

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DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

As may be seen in figures 1 and 2, the mooring arrangement, in this case a tanker 1, is moored to the floor 2 of a body of water 3 by means of a buoy 4, 6 with an integrated rigid arm 5. The buoy consists of a load-carrying shaft 4 and a rotating member 6. The anchor chain or chains 7 are connected to the load-carrying shaft 4 and to the anchor point(S) 8 on the floor 2 of the body of water. The rotating member 6 is free to rotate about the vertical axis of the load-carrying shaft 4. The rigid arm 5 is integrated into the rotating member 6, and thus is also free to rotate about the vertical axis of the load-carrying shaft 4. The rigid arm 5 is connected to the mooring arrangement 1 by means of a universal joint 9. The universal joint 9 consists of: a horizontal pivot 11 located at the end of the rigid arm 5 (to enable the rigid arm 5 to make vertical motions in relation to the tanker 1 as a result of wave action); and, perpendicular to this, a pivot 10 located adjacent to the mooring arrangement 1. This pivot 10 has its axis A-A inclined at an angle of 20-50° from the vertical, but in the plane of the centreline of the mooring arrangement 1. A third connection 12, rotational in nature, and perpendicular to the inclined vertical pivot 10, is optionally fitted between the inclined vertical pivot 10 and the horizontal pivot 11.

The value of the restoring moment when the rigid arm 5 moves out of line with the centreline of the mooring arrangement 1 is governed by the weight of the rigid arm 5, the weight that loads the horizontal pivot 11, and the angle of inclination from the vertical of the axis A-A of the pivot 10. By loading ballast 13 into the vessel end of the rigid arm, the effectiveness of the restoring moment can be improved.

The fluid conduit connecting the mooring arrangement 1 with the pipeline 14 on the floor 2 of the body of water 3 consists of a flexible hose or pipe 15 connecting the pipeline 14 on the floor 2 of the body of water 3 with the load-carrying shaft 4 and rotating member 6. A fluid swivel 16, of a type known to those skilled in the art, is provided in the rotating member 6 in order to allow free rotation of the said rotating member 6 and rigid arm 5 about the vertical axis of the load-carrying shaft 4 without spillage of fluid. A fluid swivel 16 providing for several parallel pipes or hoses, of a type known to those skilled in the art, may be optionally

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incorporated into the apparatus of the present invention. The pipe or hose 17 emerges at a location concentric with respect to the rotating member 6, and is arranged over the rigid arm 5.

- 5 The pipe or hose 17 is then arranged over the universal joint 9 and terminates at its contact point 20 with the mooring arrangement 1. A flexible hose 18 may optionally be used to jump the horizontal pivot 11; and another flexible hose 19 may optionally be used to jump the inclined vertical pivot 10. A fluid swivel 21, of a type known to those skilled in the art and suitable for single or multiple piping, is used to jump the rotational connection 12

The rigid arm 5 and the rotary member 6 are fitted with railings 22.

- 15 The figures 1 and 2 show a CALM (Catenary Anchor Leg Mooring) apparatus. Furthermore, the invention is also applicable in combination with all other SPM (Single Point Mooring) apparatus, such as the SALM (Single Anchor Leg Mooring) buoy, laid open to public inspection in the Dutch Patent Application 7600189.

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CLAIMS

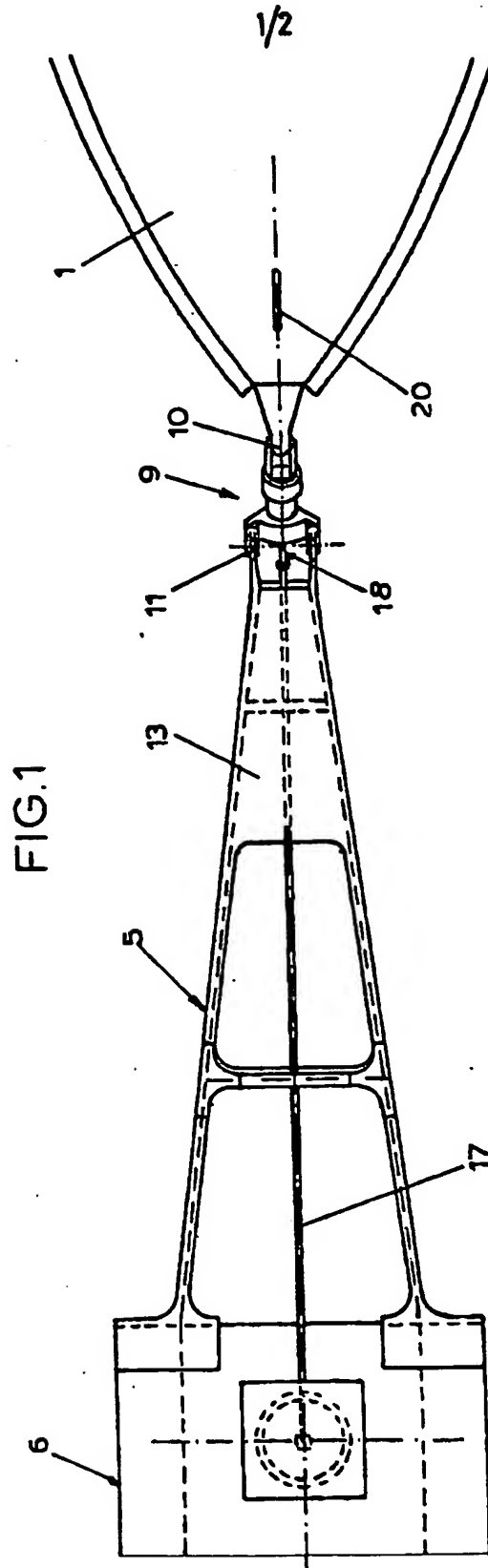
What I claim is:

1. A buoy and mooring arrangement floating on the surface of a body of water, said buoy anchored to the floor of said body of water by means of one or more anchor points and anchor chains, said mooring arrangement being connected to said buoy by means of a single rigid arm, said rigid arm being fitted at one end, in a fixed or pivotable manner to said buoy, such that said mooring arrangement can rotate about the vertical axis of the buoy, said rigid arm being fitted to said mooring arrangement via a universal joint, consisting of one vertically pivotable connection having an axis inclined from the vertical at the vessel end of said universal joint, and a second pivotable connection rotating about a horizontal axis, said inclined vertical pivot and said horizontal pivot separated a certain distance.
2. The buoy with mooring arrangement of claim 1 and further comprising: an axial rotational connection which is located between said inclined vertical pivot and said horizontal pivot.
3. The buoy with mooring arrangement of claim 1 and further comprising: a ballast chamber located in the rigid arm.

BAD ORIGINAL



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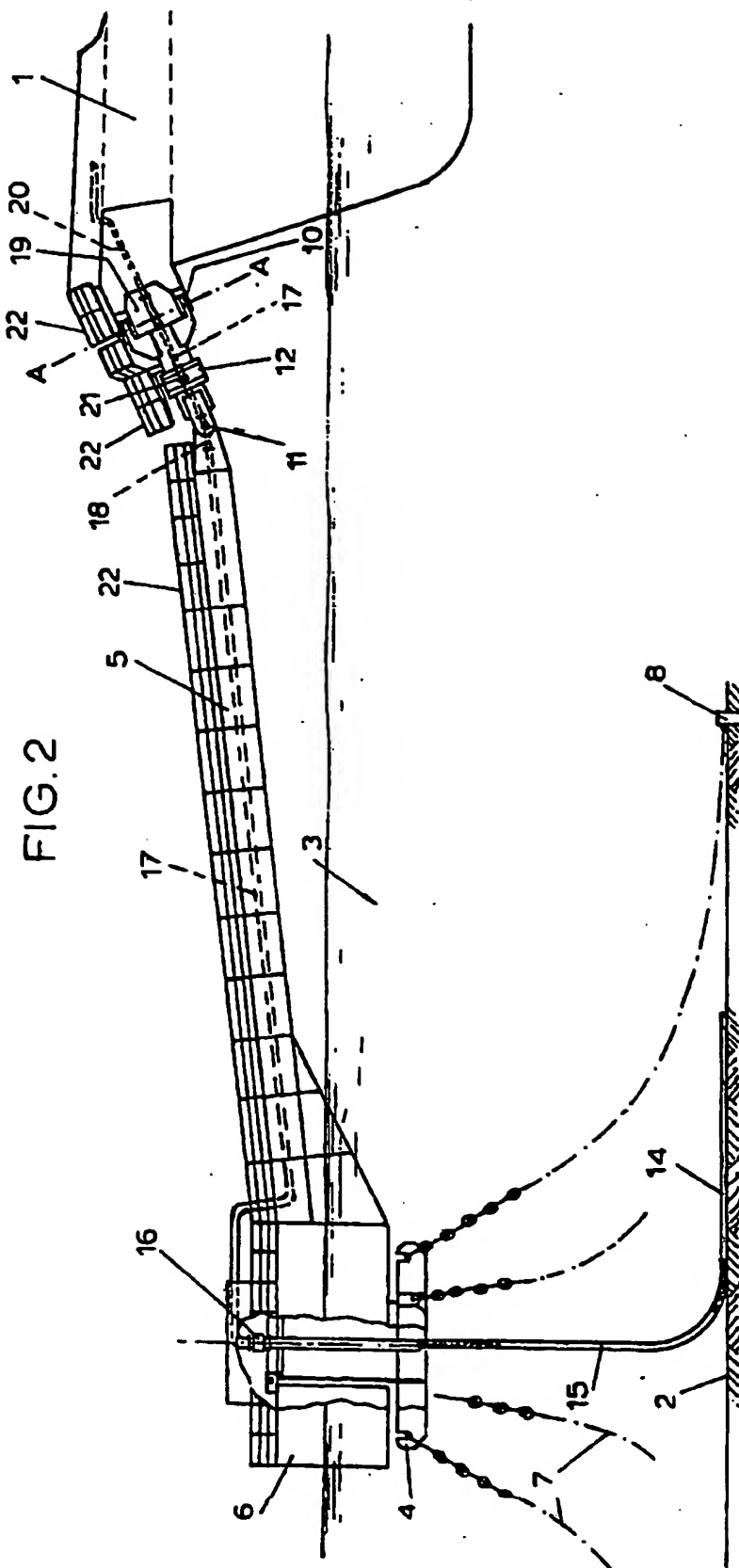


FIG. 2

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European Patent
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EUROPEAN SEARCH REPORT

Application number
EP 81 20 1094

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	<u>US - A - 4 176 615 (REID)</u> * Whole document * --	1,2	B 63 B
	<u>FR - A - 2 391 903 (ACB)</u> * Page 4, line 34 to page 5, line 8; figures 1-6 * --	2	
	<u>US - A - 2 882 536 (JORDAN)</u> * Columns 3,4; figures 1-4,7,8 * -----	1,3	TECHNICAL FIELDS SEARCHED (Int. Cl.) B 63 B 35/44 B 63 B 27/24
			CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons A: member of the same patent family. corresponding document
<input checked="" type="checkbox"/> The present search report has been drawn up for all claims			
Place of search	Th Hague	Date of completion of the search	Examiner
		11-12-1981	DE SCHEPPER

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